Winter Conditions of Vegetation.

BY

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THESIS

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Winter Conditions of Vegetation.

Although this is a very broad and interesting subject, I have been able to find but very little literature published on it. There are two articles in the report of the Iowa Agricultural Experiment Station for 1889. "A Chemical Study of Apple Twigs" by G. E. Patrick and "An Investigation of Apple Twigs" by Professor B. D. Halsted. One article in the Illinois Natural History Bulletin for 1876, "The Tree in Winter", by Frederick Brendel, and one in the Botanical Gazette for June 1892, "The Identification of Trees in Winter", by Aug. F. Foerste.

The material used for investigation was collected on or near the University grounds. It has been my object to find out some of the general characteristics of vegetation during winter.

I have cut sections of several kinds of twigs and examined, by means of the iodine test, for starch. In this way only the location and comparative amount of starch can be determined. I also made some internal structural examinations of twigs.

A great many if not all of our trees have peculiar characteristics by which they can be determined in winter as well as in summer. In this paper an attempt at describing some of these trees will be made.

Another series of interesting experiments was on the determination of the amount (per cent) of volatile elements in the wood during winter The material for these tests was collected in the western part of Vermilion County. The first series of experiments were carried on during

the latter part of February and the first of March. The second during the middle of April, and the third during May.

Trees in Winter.

As we look about us in winter we see a great many trees that we readily recognize by some peculiar characteristics. For instance, the bark of the shell bark hickory, the white bark and slender branches of the birch, the dried up scales of the thin outer bark of the sycamore peeling off and exposing the light colored bark, and a great many other less conspicuous characteristics.

The following observations and descriptions were taken from trees on the University grounds:

1. Acer dasycarpum, Ehrh. (Soft Maple).

A very large tree, 50-60° tall, branches numerous and medium size, trunk with thin scales; twigs medium size, darker color than older branches, glabrous, with small white blotches; leaf scars, opposite, decussate, horse-shoe shaped, convexity downward, with bud in the crescent, opposite scars forming a continuous ring around the stem; buds small, glabrous, flower parts protected by four somewhat hardened outer bud leaves, internodes from 1-1 1/2 in.

2. Acer saccharinum, Wang. (Hard Maple).

Large tree 30-50° tall, somewhat spreading branches, twigs small and darker colored than the soft maple; twigs small with white blotches glabrous, young twigs darker green than the soft maple; leaf scars opposite, decussate, two opposite scars crescent shaped with the ends

meeting around the stem; buds small, conical, dark brown, made up of a series of four leaves somewhat hardened, thus serving as a protection for the inner flower parts, internodes from 1/2-2 in.

3. Betula papyrifera, Marsh. (Birch).

Medium sized tree, 20-30° tall, bark of the trunk white, easily peeled off in thin transverse sheets; twigs small brownish green, glabrous, leaf scars small, below the buds, 1/2 ranked; buds comparatively large, three series of leaves forming the outer covering, dark brown, waxy.

4. Catalpa bignonioides, Walt.

Trees rather large, 25-40°high, branches and twigs rather large, light green color, the thickness and stiffness of the twigs and branches give the tree a rough, rigid appearance in winter; leaf scars, three decussate, raised, almost circular, presenting a concavity with a raised margin, about 1/4 in. in diameter on young twigs; buds very nonconspicuous, found in axil of leaf scar, internodes from 2-3 in.

5. Castanea vesca, var Americana, Mill. (Chestnut).

A very large tree with smooth bark, dark green color; twigs rather small, short, young twigs lighter green color than the older branches; leaf scars, tending toward 1/2 ranked arrangement, but all are somewhat inclined to the upper side of the twig; buds appear in the axils of the leaf scars, one appearing to the right of the center of the scar and the next above or below to the left, thus making the buds appear opposite-alternate, internodes 1-1 1/2 in; buds protected by two hardened

outer bud leaves, greenish brown, inner leaves soft downy coating.

6. Celtis occidentalis, L. (Hackberry).

Large tree, 60-70° tall, bark on the trunk rough and rigid, many branches, spreading; twigs small, short, lighter color than older branches; leaf scars, small, 1/2 ranked, do not surround the stem; buds slender, conical, close to stem, dark brown, pubescent, the imbricated outer four leaves form the protection for the flower parts, internodes from 3/4-1 in.

7. Cercis Canadensis, L. (Red Bud).

Small tree, 12-18° tall, flattened spreading top, bark dark brown, rough; twigs small, crooked, young twigs lighter color than the older branches; leaf scars 1/2 ranked, rather large, flat, not surrounding the stem; buds very small, in axils of leaf scars, outer bud leaves dark brown, hardened, glabrous, internodes from 1 1/2-2 in.

8. Cornus florida, L. (Flowering Dog Wood).

Small tree, 15-25° tall, general color of the trunk and branches dark brown, slender rather than spreading; twigs small, slender, stiff, much darker color than older branches; leaf scars opposite, decussate, a swelling of the stem beneath each scar, stem above two opposite scars seems to fit into the part below; buds not conspicuous, small, somewhat flattened terminal balls on some of the twigs, internodes from 2-3 in.

9. Diospyros Virginiana, L. (Persimmon).

Medium sized tree having somewhat the appearance of the plum, dark brown color, hard wood; twigs small, a little lighter brown than the

branches, not glabrous; leaf scars, 1/2 ranked, a slight swelling of the twig beneath the scar, does not surround the stem; buds in the axils of the scars, small, conical, outer covering formed by two very hard dark brown bud leaves, internodes from 1-1 1/2 in.

10. Fraxinus quadrangulata, Michx. (Blue Ash).

Tree large, 50-65° high, branches large, stiff with thickened quadrangular twigs this being the special feature in distinguishing it from the other species of Fraxinus; leaf scars opposite, decussate, large, semi-lunar, convex side down; buds in concavities of leaf scars, large, four series of bud leaves forming the outer covering, internodes of young twigs 3-4 in.

11. Gleditschia tricanthos, L. (Honey Locust).

Large tree, smooth bark, branches not very numerous, rather long and stiff; twigs medium size, barren, long hard thorns borne above the leaf scars, this is a special characteristic of the tree; leaf scars 2/5 ranked, the twigs have a slight zigzag appearance, but not so much as the coffee tree, scars are on the convexities of the twigs; no buds apparent in winter, internodes 2-2 3/4 in.

12. Gymnocladus Canadensis, L. (Coffee Tree).

Medium sized tree with long sprangly branches, bark smooth, dark green; twigs very crooked, somewhat of a zigzag appearance; leaf scars 2/3 ranked, very large and conspicuous always on the apices of the angles formed by the zigzag growth of the twig; buds scarcely visible, in the axils of the leaf scars, internodes 2-3 in.

13. Larix Americana, Michx. (Larch).

Rather large tree with long, slender, drooping branches. Unlike most of the Conifarae the needle shaped leaves do not remain on during winter; twigs bear small, globular spurs, from 1/15-1/8 in.long, having a closely imbricated structure, dark brown, rough appearance, 2/5 ranked, these protuberances are very close together, only from 1/2-3/4 in. from one to the next above or below.

14. Morus rubra, L. (Red Mulberry).

Large tree, light green bark, twigs rather small and about the same color as the branches; leaf scars 1/2 ranked, with tendency toward upper side of the stem; buds small, outer covering made complete by four hardened bud leaves, brown color, glabrous, internodes 1 1/2-2 in.

15. Magnolia acuminata, L. (Cucumber Tree).

Large tree, 60-90° tall, with comparatively few branches, rather large and stiff, bark dark green, smooth; twigs rather large, stiff, glabrous, brownish-green, young twigs darker color than older branches; leaf scars,horse-shoe shaped, with a bud in the crescent of each, small scar extends around the stem with a downward curve on the side opposite the bud; buds small, slender, pointed, pubescent, dove colored, bud leaves forming the covering are grown together so that it is very hard to distinguish the outlines of the leaves, internodes from 1 1/2-2 in.

16. Maclura aurantiaca, Nutt. (Hedge).

Medium sized tree, 30-40° tall, with small stiff branches, bark

yellowish green, peeling off in thin paper-like longitudinal strips; roots have yellow bark and wood; twigs slender, stiff, darker color than older branches; leaf scars, 3/5 ranked, raised, usually with thorns in the axils; buds nonconspicuous in winter, but when they do appear they are at the sides of the thorns.

17. Negundo aceroides, Moench. (Box Elder).

A large tree with general appearance resembling the maple, the bark of the trunk of the elder is more rigid and the buds have more of a downy coating than the maple; twigs about the same size as the soft maple, but lighter color; leaf scars, below the buds, opposite, decussate, the scars of two opposite buds meet forming an obtuse angle with a pointed apex extending upward; buds rather large, protected at the base by two hardened scales, between these scales are three buds, the central one being the largest, each bud has four bud leaves forming the outer coating, pubescent, internodes from 1 1/2-3 in.

18. Populus monilifera, Ait. (Cotton Wood).

A very large tree, 60-75° tall, large, long branches, bark of trunk very rigid, toward the top the bark has a whitish appearance; twigs, thick and rough, not very long, rings showing each year's growth are very conspicuous; leaf scars, large, 2/5 ranked, swelling of the twig below each scar gives the scar a projecting appearance; buds in axils of leaf scars, long, conical, sharp pointed apex, protected at base by bud scales, outer, brown bud leaves covered with a kind of wax or gum and a slight pubescense which serve as protectors in winter; internodes 1 - 1 3/4 in.

19. Platanus occidentalis, L. (Sycamore).

Very large tall tree, with light green twigs and trunk covered with thin brittle scales, under which is a whitish bark; twigs rather large and stiff; leaf scars almost surround the buds, small scar extending from the bud around the stem; bud, conical, at an angle of about 20° with the stem, two oily, dark brown, leaves surround the inner soft downy parts; internodes from 2-2 1/2 in.

20. Pyrus Americana, D. C. (Mountain Ash).

Small tree, smooth, glabrous, dark green bark, long, slender limbs; twigs, medium size, long, more of a brownish color than the older branches, glabrous; leaf scars not very conspicuous, 1/2 ranked, appear on a slight swelling of the stem; buds rather large, long, outer covering formed by three series of bud leaves, brown, pubescent, internodes 2-3 in.

21. Pinus strobus, L. (White Pine).

A large tree with smooth bark, leaves borne on the ends of the branches or branchlets; leaves 2 1/2-3 1/2 in. long, five in a sheath, slender, very flexible, triangular, sheath scars appear close together, 3/8 ranked.

Special characteristics are the flexible leaves and light color.

22. Pinus sylvestris, (Scotch Pine).

Medium sized tree, with a rough reddish bark; the tree has generally a rough scrubby appearance; leaves 2-3 in. long, two in a sheath, not so slender and flexible as those of the white pine, semi-cylindri-

cal, channelled, borne farther down on the branches than those of the white pine and the general color of the leaves is darker.

23. Quercus robus, (European Oak).

Similar in general appearance to our native black oak, but the top seems to be more bushy and does not grow so tall; twigs medium size, stiff, longitudinal ridges extending down the stem from the leaf scar, light brown and green color, forming a sort of mottled appearance; leaf scars triangular in shape, 2/5 ranked, rather conspicuous, projecting; buds in axils of leaf scars, conical, globular, outer covering brown, glabrous, formed by three series of leaves, internodes from 1-2 in.

24. Salisburia adiantifolia, (Ginkgo).

Not a very tall tree as found here. It is a native of Japan. Bark light brown, has a kind of stringy appearance; twigs thick and stiff; buds are peculiar in their growth, project out almost perpendicular to the stem, base surrounded by five small,leaf scars, outer leaves of bud reddish brown, 3/5 ranked, internodes from 1 1/2-2 1/2 in.

25. Salix nigra, Marsh. (Willow).

Large tree, 50-60° tall, with rather spreading branches, long and slender, bark of trunk rigid; twigs small, rather short, lighter color than older branches, dark green, glabrous; leaf scars, small, below the buds, 3/5 ranked; buds long, with pointed apex, soft, pubescent bud leaves and flower parts surrounded by a hardened,pubescent sheath,which opens on side next to the stem, internodes from 1/2-1 in.

a mucilaginous inner bark; twigs small, numerous, dark green, lighter color than the older branches, project either straight out or upwards; leaf scars, 1/2 ranked, semi-circular, above a slight swelling of the stem; buds, globular, somewhat flattened, reddish, pubescent, outer covering formed by four series of leaves; internodes from 1/2-3/4 in.

30. Ulmus Americana, L. (White Elm).

Large tree, large spreading branches with drooping branchlets, bark of the trunk not so rigid as the red elm; twigs, short, smaller than red elm, drooping, dark green, but a little brighter color than the older branches; leaf scars 1/2 ranked, slight swelling of the stem below each scar, semi-circular; buds, rather long, conical, glabrous, four series of leaves forming the outer hardened coating, differing from the red elm in being more slender, and glabrous; internodes from 1/2-1 in.

Tests for Amount of Water in Wood.

For these experiments the material for the first set was collected near Armstrong, in Vermilion County, February 23,-'93. Small circles of limbs and trunks of trees were used. Parts were taken from the center, part inside the bark and the bark. Each weighed separately, dried perfectly dry in a water bath and weighed again. It was found that the greatest losses of weight by drying were found in the soft wood such as Linn and Willow and that the greatest per cent of loss was in the center. In these the highest per cent of water was 63% in the swamp willow. In some of the harder wood, such as wild plum, hickory, oak etc.

the per cent of loss by drying was much less and the reverse order. The most water being found in the bark and decreasing toward the center The lowest per cent of water was found to be in the heart of Osage Orange, that being 22%.

The above seem to bethe general rules. In summing up the per cents of water in all experiments tried, I find the average per cent of water to be 37.4. This surely proves that the sap does not go down to the roots in winter. I also tried the same experiments on some roots of Osage Orange and found that they lost but very little more weight, by drying, than the limbs.

Material for the second set of experiments was collected in the woods north of Urbana, April 25th,'93, and for the third, in the woods two and one half miles south west of Potomac in Vermilion Co.

The following tables will show the results of experiments tried. The first column giving the diameter of circles taken; under the next, percent lost by drying. No.1. is from the center, No. 2. between center and bark, and No. 3. the bark.

Col. Feb. 23,-'93. % lost by drying.

Name.	D. in.	No.1.	No.2.	No.3.	
Swamp Willow	4 1/2	63	53	44	
Linn	2	60	59	51	
Soft Maple	2	47	51 1/2	44	
" "	6	40	46	36	
" "	3 1/2	45	47	43	
Red Haw	1 1/4	40	36	37 1/2	
" "	2 1/2	33	38	29	
Black Oak	3	34	36	22	
Wild Plum	2 1/4	28	34	38	
Hedge	2	22	26	38	
Apple	1	38	38	51	
"	3	29	37	49	
Ash	2 1/4	28	28	31	
"	9	24	29	38	Base of tree.
Burr Oak	4 1/4	35	34	36	
Hickory	4 1/2	31	31	38	
"	1 3/4	29	30	36	
White Oak	3	26	31	30	
Averages		36.8	37	38.4	

Gen. Ave. 37.4

Col. Apr. 25,-'93. % lost by drying.

Name	D. in.	No.1.	No.2.	No.3.
Elm	3	42	36	39
Red Haw	4	37	39	33
Black Oak	3 1/2	36	36	26
Hickory	4	29	34	39 1/2
Hard Maple	2 3/4	31	28 1/2	31
Soft Maple	3	35	34	40
Swamp Willow	2 3/4	59	49	42
Averages		38.6	36.6	35.8

Gen. Ave. 37.

Col. May 12,-'93. % lost by drying.

Name	D. in.	No.1.	No.2.	No.3.
Honey Locust	2 1/2	35	34	43
Osage Orange	2 3/4	23	32	47
Red Bud	1 1/2	38	21	36
Burr Oak	2	53	33	36
White Oak	3 1/2	26	35	40
Hackberry	2	34	47	45
Hickory	2 1/4	29	34	50
Red Haw	2	30	38+	38-
Black Oak	3	36	35	26
Sassafras	2	32	34	45
Ash	2 1/2	27	28	42
Wild Plum	1 3/4	31	36	48
Elm	1 3/4	31	36	45
Wild Cherry	1 1/4	30	38	47
Prickley Ash	1	26	31	48
Iron Wood	1 1/2	35	36	29
Linn	3 1/2	57	58	47
Buckeye	2 1/4	50	47	42
Soft Maple	2 3/4	34	39	53
Swamp Willow	2 1/2	40	48	42
Averages		34.8	37	42.4

Gen Ave. 38.

Starch.

In making tests for starch, thin sections were cut of the material in hand and iodine solution applied. The starch was colored blue and could be readily detected under the microscope. In this way only comparative amounts of starch could be determined. The work was done on this material during the months of January and February.

In the perennial roots, where the tops of the plant, or shrub, die down to the ground each year, starch is found in abundance. But in other plants where the tops live through the whole year, starch is to be found in the various parts of the top as well as in the roots.

The following are some of the tests that were made:—

1. Sections of a pear twig showed a slight deposit of starch in the Medullary rays along the internodes, and at the bases of the buds the cells seemed to be filled with starch. There is an extra deposit of starch at swelling below each bud.

2. Sections of an apple twig showed deposits of starch similar to the pear twig.

3. Sections of Berberis vulgaris showed but a very slight trace of starch in the medullary rays, no special difference between the nodes and internodes.

4. Sections of Catalpa showed no traces of starch.

5. Sections of May Cherry twigs showed no traces of starch either in the twigs or buds.

6. Sections of birch twigs and buds showed no traces of starch.

7. Sections of lilac twigs showed traces of starch in the medullary rays and an abundance deposited around the borders of the pith in the woody tissues. No starch found in the buds.

8. Sections of peach twigs showed deposits of starch similar to the apple and pear, but found most abundant around the pith, some few grains scattered through the pith.

9. Sections of box elder twigs showed no starch in the buds and but very little in the internodes, where granules were scattered between the medullary rays.

10. Sections of osage orange showed a large deposit of starch around the pith and between the medullary rays. Especially great deposit of starch at the bases of the thorns, below the leaf scars.

11. Sections of hard maple twigs and bud very similar to the box elder. But very little starch and that only between the medullary rays.

12. Sections of white elm twigs, showed but a slight deposit of starch, scattered in the medullary rays, more abundant at the base of the buds.

13. Sections of a blackberry stem showed an abundance of large grains of starch in the medullary rays, a few small grains in the bark and pith. Sections of a very small fibrous root showed no starch, but in the larger roots near the base of the stem, found an abundance of starch. There seemed to be more in the roots than in the stem.

14. Sections on an elder stem showed very little starch in the woody tissues, none in the pith. Sections of the roots of the same

plant showed an abundance of starch in the wood tissues, but none in the outer soft bark.

15. Sections of roots of the wild cherry showed a great deposit of starch.

16. Sections of a twig from a rose bush, cut about four inches from the end, showed an abundance of starch around the pith and in the medullary rays, some through the cells of the central pith and in the pith cells of the wood tissue. Sections through the bud and stem, no starch in the bud but a greater deposit in the stem on the side next to the bud.

17. Sections of ash twigs showed a deposit of starch around the pith and in medullary rays similar to that of the peach twig. No starch in the buds, but an extra amount below the bud in the stem.

18. Sections of a grape vine cut about ten inches from the end, showed deposits of starch all through the stem, but very little through the pith, in other parts large quantities. This is the first case in which starch was found in the buds.

19. Sections of larch twigs showed but very little starch deposited and that scattered in the medullary rays.

20. Sections of bald cypress twigs showed deposits of starch similar to the larch. In all species of Coniferae examined, similar conditions were found. In all these the annular rings showed quite prominent also.

21. Sections of twigs of Salix nigra showed but very little starch

very similar to the maples. In these the annular rings of growth were quite prominent, similar to the pines.

Chemical Tests for Starch.

For this work I collected some blackberry roots in April, before growth set in, and again the 19th of May after the leaves were well out. I also collected stems and roots of Catalpa on May 5th and May 19th. The first time the buds were beginning to grow, and the last time the leaves were well out.

For the tests Sachsse's method was used for the determination of starch, found on page 132 of the Annual Report of the Connecticut Agricultural Experiment Station for 1887. The air dry material finely ground was used.

	1st. % lost by drying.	2nd. % of starch in the dry material.
Blackberry roots.		
Col. Apr. 19th.	--	35
" May 19th.	58	31 1/2
Stems " " "	41	17 1/3
Catalpa roots.		
Col. May 5th,	59	25
" " 19th,	62	32
Stems " " 5th,	44	24 1/2
" " " 19th,	26	19 1/4

References to Plates.

The twigs from which these photographs were taken, were collected the first of March.

Plate, I.

1. & 2. Fraxinus Americana, L. (White Ash)
3. Larix Americana , Michx. (Tamarack)
4. Betula papyrifera, Marsh. (White Birch)
5.& 6. Acer dasycarpum, Ehrh. (Soft Maple)
7. Ulmus fulva, Michx. (Slippery or Red Elm)
8. & 9. Negundo aceroides, Moench. (Box-elder)
11. Lilac.

Plate, II.

1. & 2. Fraxinus quadrangulata, Michx. (Blue Ash)
3. Ostrya Virginica, Willd. (Iron Wood)
4. Platanus occidentalis, L.(Sycamore)
5. Morus rubra, L. (Red Mulberry)
6. Castanea vesca, Mill. var. Americana,(Chestnut)
7. & 8. May Cherry.
9. Catalpa speciosa, Warder.
11. Liriodendron tulipifera, L. (Tulip-tree)
12. Gymnocladus Canadensis, L. (Coffee-tree)

Plate, III. 1. Salix nigra, Marsh. (Black Willow)

2. Gleditschia triacanthos, L. (Honey Locust)

3. Acer dasycarpum, Ehrh. (Soft Maple with drooping branches.)

4. Tilia Americana, L. (Basswood)

5. Maclura aurantiaca, L. (Osage Orange)

6. Ulmus Americana, L. (American Elm)

7. Populus monilifera, Ait. (Cotton-wood)

8 Cercis Canadensis, L. (Red-bud)

9. Acer saccharinum, Wang.var.nigrum, (Hard Maple)

10. Celtis occidentalis, L. (Hackberry)

11. Diospyrus Virginiana, L. (Persimmon)

12. Betula populifolia, Ait. (Gray Birch)

13. Taxodium distichum, Richard. (Bald Cypress)

Plate, IV. 1. Picea excelsea, (Norway Spruce)

2. Picea rugra, Link. (Black Spruce)

3. Pinus strobus, L. (White Pine)

4. Pyrus Americana, DC. (Amer. Mountain Ash)

5. Salisburia adiantifolia, (Ginkgo)

6. Quercus robra, (European Oak)

7. Cornus florida, L. (Flowering Dogwood)

8. Tsuya Canadensis, Carr. (Hemlock)

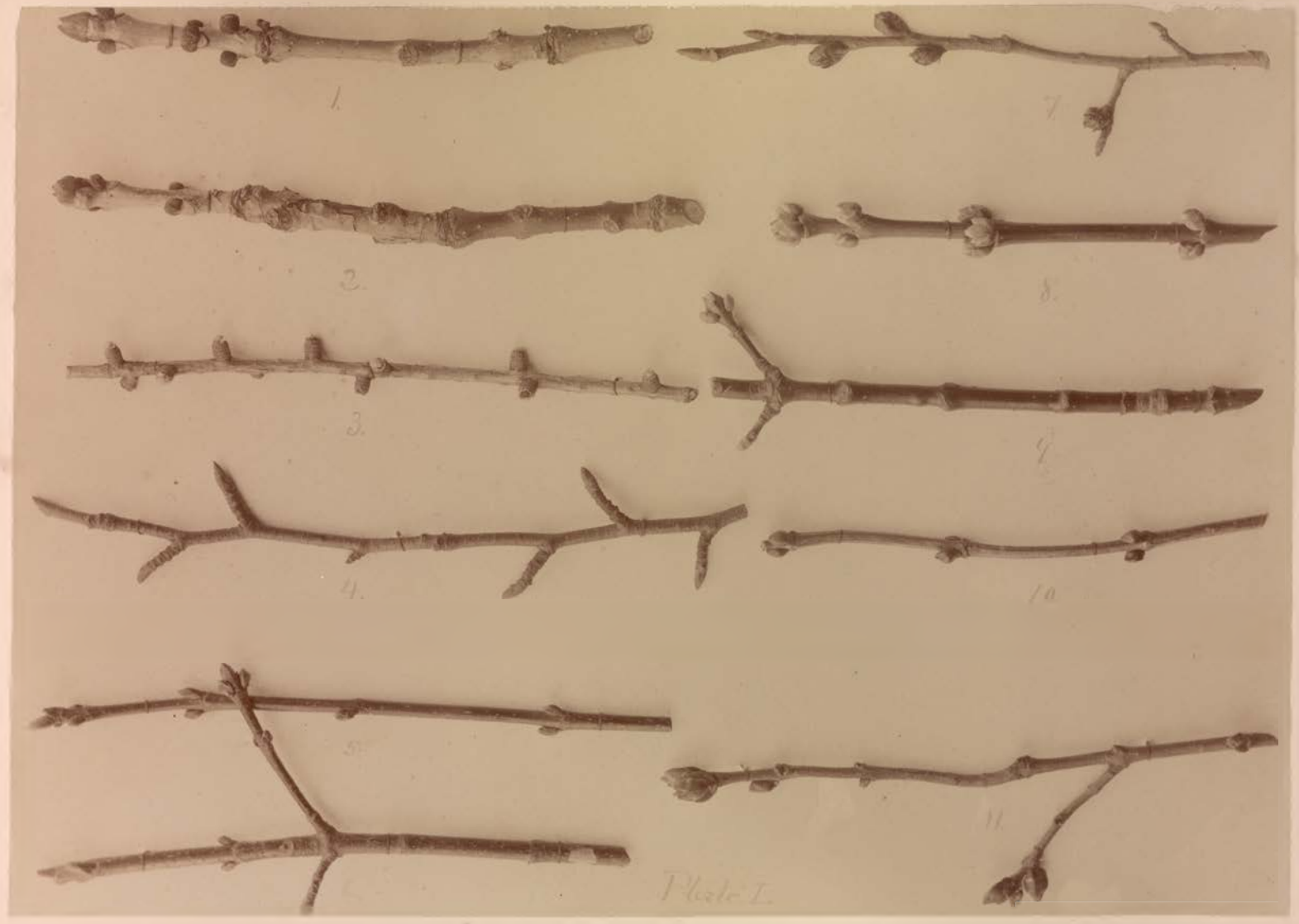
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Plate I.

Plate II.

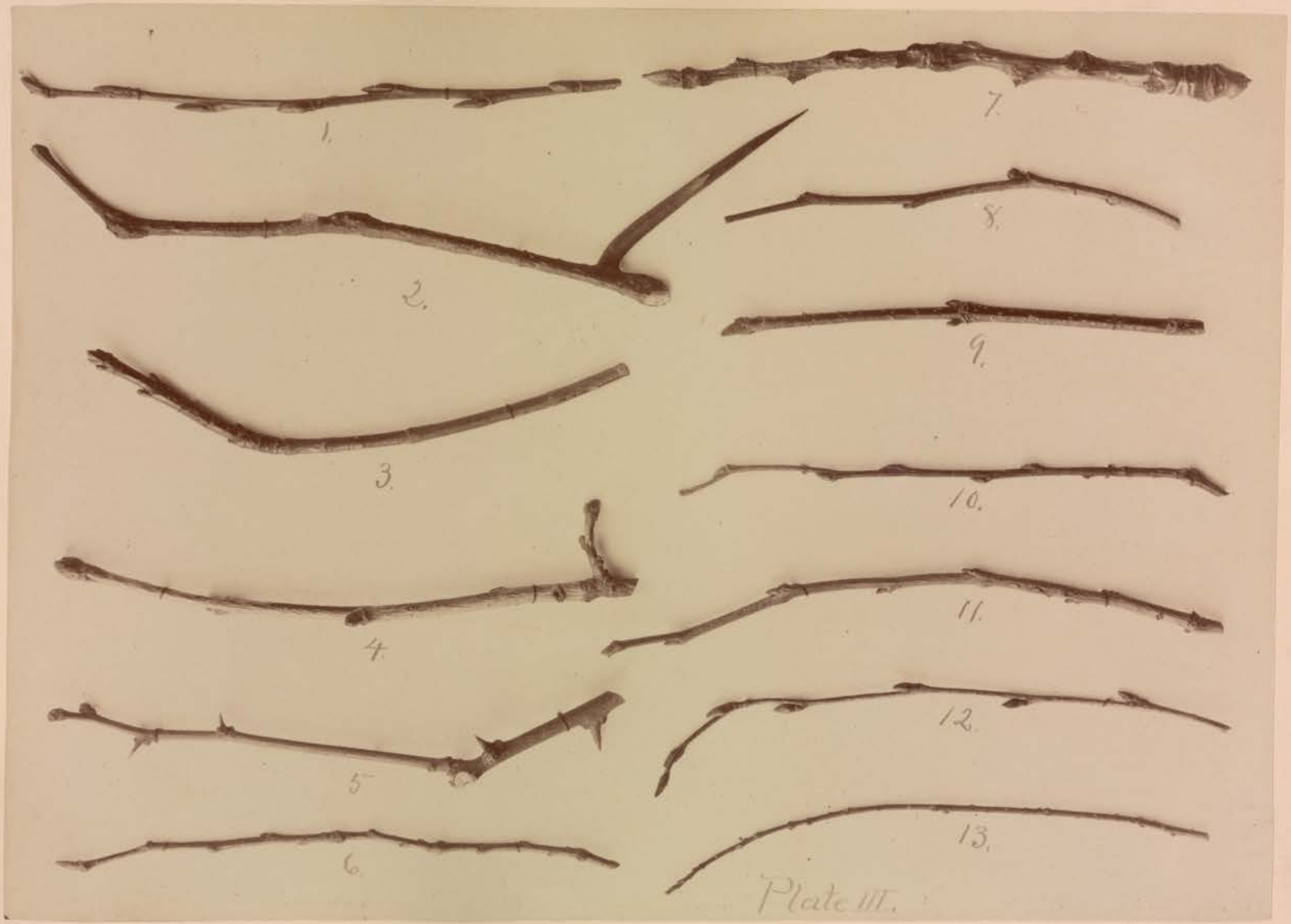
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Plate III.

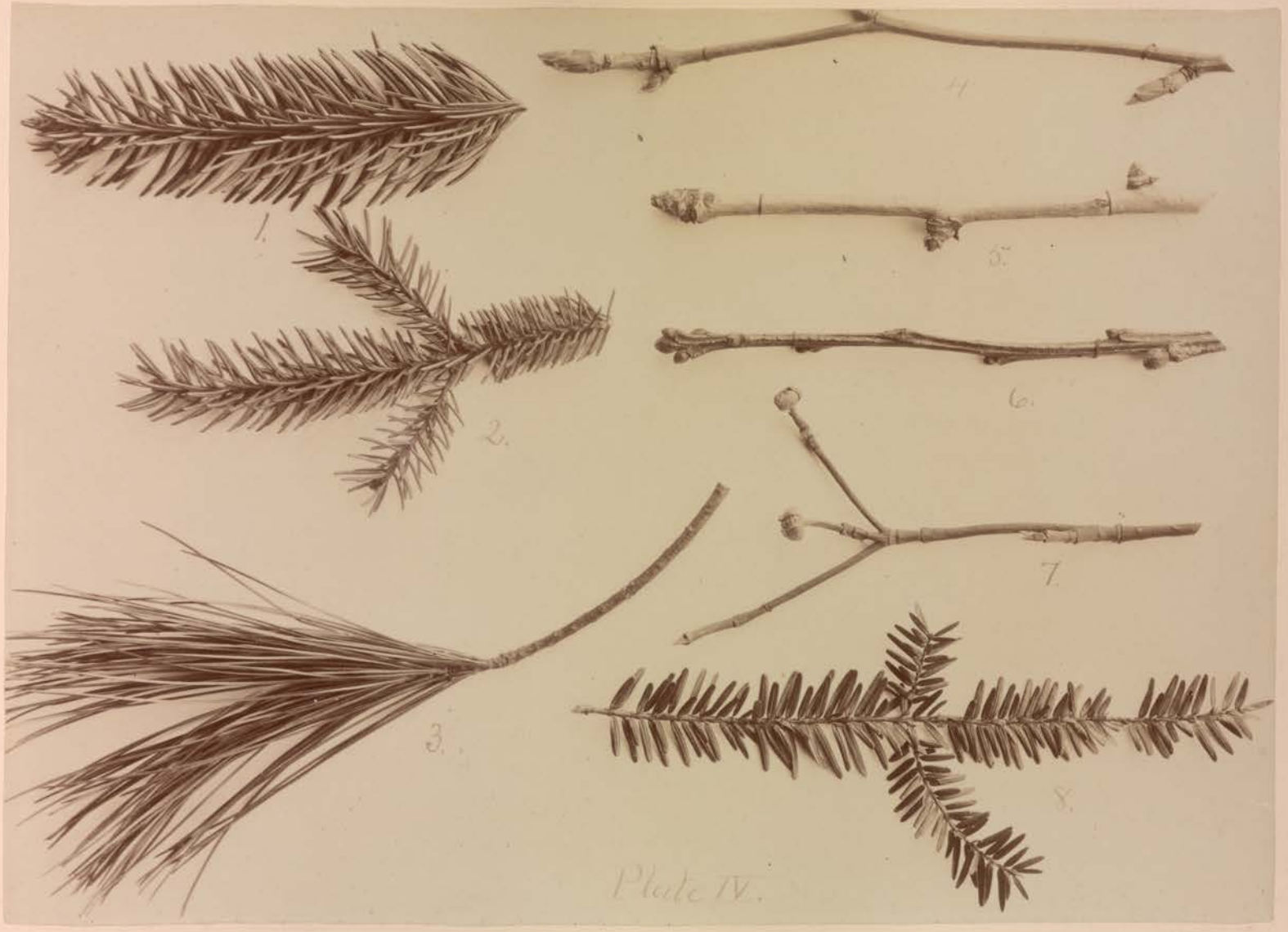

Plate IV.